substantially pure fibronectin, substantially pure fibronectin fragments, or a mixture thereof, to produce transduced hematopoietic cells, said fibronectin and said fibronectin fragments containing the alternately spliced CS-1 cell adhesion domain and the Heparin II binding domain of fibronectin.

12. The method of claim 11 which includes harvesting the transduced hematopoietic cells.

13. The method of claim 11 wherein the hematopoietic cells have a protein deficiency or abnormality and the recombinant retrovirus vector includes an exogenous gene encoding the protein.

14. The method of claim 11 wherein the hematopoietic cells have an enzyme deficiency or abnormality and the exogenous gene is a gene encoding the enzyme.

15. The method of claim 14 wherein the hematopoietic cells are human hematopoietic cells having an enzyme deficiency or abnormality and the exogenous gene is a human gene encoding the enzyme.

16. The method of claim 14 wherein the hematopoietic cells have an adenosine deaminase deficiency and the exogenous gene encodes adenosine deaminase.

17. The method of claim 15 wherein the human hematopoietic cells have an adenosine deaminase deficiency and the exogenous gene encodes adenosine deaminase.

18. The method of claim 15 wherein the cells are infected with the retrovirus in the presence of an immobilized fibronectin fragment containing an

amino acid sequence which provides the cell-binding activity of the CS-1 domain and an amino acid sequence which provides the retrovirus binding activity of the Heparin-II domain.

19. The method of claim 18 wherein the fibronectin fragment is a recombinant fibronectin fragment.

20. The method of claim 19, wherein the recombinant fibronectin fragment is selected from the group consisting of H-296 and CH-296.

21. The method of claim 20, wherein the recombinant fibronectin fragment is CH-296.

22. The method of claim 19, wherein the recombinant fibronectin fragment contains the Heparin-II binding domain of fibronectin.

23. The method of claim 11, wherein the hematopoietic cells are characterized as adherent-negative, low density, mononuclear cells.

24. An improved method for cellular grafting, comprising the steps of:

obtaining viable hematopoietic cells from an animal donor;

infecting the viable hematopoietic cells with a replication-defective recombinant retrovirus vector containing exogenous DNA to produce transduced viable hematopoietic cells, the infecting being in the presence of an immobilized amount of fibronectin and/or a fragment thereof effective to increase the efficiency of cellular transduction by the retrovirus vector; and

introducing the transduced viable hematopoietic cells into an animal recipient as a cellular graft.

25. The method of claim 24, wherein said infecting is in the presence of a fragment of fibronectin containing the Heparin-II binding domain of fibronectin.

26. A cellular population suitable for subjection to retroviral-mediated gene transfer, comprising:

viable hematopoietic cells in a culture medium containing immobilized fibronectin, immobilized fibronectin fragments, or an immobilized mixture thereof.

27. The cellular population of claim 26, wherein the culture medium contains a recombinant fibronectin fragment selected from the group consisting of CH-296 and H-296.

28. The cellular population of claim 26, wherein the culture medium contains immobilized fibronectin fragments containing the Heparin-II binding domain of fibronectin.

29. A culture medium capable of sustaining viable hematopoietic cells and which contains immobilized fibronectin, immobilized fibronectin fragments, or an immobilized mixture thereof.

30. The culture medium of claim 29, which comprises immobilized recombinant fibronectin fragment selected from the group consisting of CH-296 and H-296.

31. The culture medium of claim 29, wherein the culture medium contains immobilized fibronectin fragments containing the Heparin-II binding domain of fibronectin.

32. A method for increasing the frequency of transduction of hematopoietic cells by a replication-defective recombinant retrovirus vector, comprising infecting a

population of viable hematopoietic cells enriched in hematopoietic stem cells with a replication-defective recombinant retrovirus vector in the presence of an effective immobilized amount of polypeptide containing a first amino acid sequence which provides the binding activity of the Heparin-II binding domain of fibronectin and a second amino acid sequence which provides the cell-binding activity of the CS-1 domain of fibronectin, to increase the frequency of transduction of the hematopoietic cells by the retrovirus vector.

33. The method of claim 32, wherein the hematopoietic cells are characterized as adherent-negative, low density, mononuclear cells.

34. The method of claim 32, wherein the culture medium comprises a recombinant fibronectin fragment selected from H-296 and CH-296.

35. The method of claim 34, wherein the culture medium comprises recombinant fibronectin fragment CH-296.

36. The method of claim 32, wherein said hematopoietic cells are obtained from cord blood.

37. The method of claim 32, wherein said infecting is in the presence of a polypeptide containing both (I) a first amino acid sequence represented by the formula: (SEQ. ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln

Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind retroviruses;

B and (ii) a second amino acid sequence represented by the formula: (SEQ. ID NO. 2)

Asp Glu Leu Pro Gln Leu Val Thr Leu Pro His Pro Asn Leu His Gly Pro Glu Ile Leu Asp Val Pro Ser Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind primitive hematopoietic cells.

Sub E1 38. A cellular population comprising viable hematopoietic cells transduced by retroviral-mediated gene transfer in the absence of retroviral producer cells and in the presence of an immobilized amount of a polypeptide containing a first amino acid sequence which provides the binding activity of the Heparin-II binding domain of fibronectin and a second amino acid sequence which provides the cell-binding activity of the CS-1 domain of fibronectin, said immobilized amount of polypeptide being effective to increase the frequency of transduction of the hematopoietic cells by the retrovirus vector.

39. The cellular population of claim 38 which is enriched in hematopoietic stem cells.

40. The cellular population of claim 38 wherein said viable hematopoietic cells are human hematopoietic cells enriched in human hematopoietic stem cells.

41. The cellular population of claim 40 which is a substantially homogenous population of human hematopoietic cells characterized as adherent-negative, low density, mononuclear cells.

42. The cellular population of claim 41 which has been transduced by a recombinant retrovirus vector containing an exogenous gene to correct a protein deficiency or abnormality in the cells.

43. The cellular population of claim 39 wherein said hematopoietic cells are obtained from umbilical cord blood.

44. A cellular grafting method, comprising:

introducing into an animal as a cellular graft, viable hematopoietic cells transduced by retroviral-mediated gene transfer in the absence of retroviral producer cells and in presence of an immobilized amount of a polypeptide containing a first amino acid sequence which provides the binding activity of the Heparin-II binding domain of fibronectin and a second amino acid sequence which provides the cell-binding activity of the CS-1 domain of fibronectin, said immobilized amount of polypeptide being effective to increase the frequency of transduction of the hematopoietic cells by the retrovirus vector.

45. The cellular grafting method of claim 44 wherein said viable hematopoietic cells are enriched in hematopoietic stem cells.

46. The cellular grafting method of claim 45 wherein said viable hematopoietic cells are human hematopoietic cells enriched in human hematopoietic stem cells.

47. The cellular grafting method of claim 44 wherein said polypeptide is a rcombinant polypeptide.

48. The cellular grafting method of claim 47, wherein said recombinant polypeptide is CH-296.

49. The cellular grafting method of claim 48 wherein said hematopoietic cells are a substantially homogenous population of human hematopoietic cells characterized as adherent-negative, low density, mononuclear cells.

50. The cellular grafting method of claim 49 wherein said hematopoietic cells have been transduced by a recombinant retrovirus vector containing an exogenous gene to correct a protein deficiency or abnormality in the cells.

51. The cellular grafting method of claim 44, wherein said hematopoietic cells are obtained from umbilical cord blood.

52. A method for increasing the frequency of transduction of hematopoietic cells by a replication-defective recombinant retrovirus vector, comprising infecting hematopoietic cells with a replication-defective recombinant retrovirus vector in the presence of an effective immobilized amount of a recombinant polypeptide containing a first amino acid sequence represented by the formula: (SEQ ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu

Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind retroviruses;

and a second amino acid sequence represented by the formula: (SEQ. ID NO. 2)

Asp Glu Leu Pro Gln Leu Val Thr Leu Pro His Pro Asn Leu His Gly Pro Glu Ile Leu Asp Val Pro Ser Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind primitive hematopoietic cells.

53. The method of claim 51 wherein the hematopoietic cells have a protein deficiency or abnormality and the recombinant retrovirus vector includes an exogenous gene encoding the protein.

54. The method of claim 51 wherein the hematopoietic cells comprise human stem cells and said exogenous gene is a human gene.

55. The method of claim 54 wherein the hematopoietic cells are characterized as adherent-negative, low density, mononuclear cells.

56. The method of claim 52, wherein said recombinant polypeptide is CH-296.

57. A cellular population comprising viable hematopoietic cells transduced by retroviral-mediated gene transfer in the absence of retroviral producer cells and in the presence of an effective immobilized amount of a recombinant polypeptide which increases the frequency of transduction of the hematopoietic cells, said recombinant polypeptide containing a first amino acid sequence represented by the formula; (SEQ. ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind retroviruses;

and a second amino acid sequence represented by the formula; (SEQ. ID NO. 2)

Asp Glu Leu Pro Gln Leu Val Thr Leu Pro His Pro Asn Leu His Gly Pro Glu Ile Leu Asp Val Pro Ser Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind primitive hematopoietic cells.

58. The cellular population of claim 57 which is enriched in hematopoietic stem cells.

59. The cellular population of claim 58 wherein said viable hematopoietic cells are human hematopoietic cells enriched in human hematopoietic stem cells.

60. The cellular population of claim 59 which is a substantially homogenous population of human hematopoietic cells characterized as adherent-negative, low density, mononuclear cells.

61. The cellular population of claim 60 which has been transduced by a recombinant retrovirus vector containing an exogenous gene to correct a protein deficiency or abnormality in the cells.

62. A cellular grafting method, comprising:

introducing into an animal as a cellular graft, viable hematopoietic cells transduced by retroviral-mediated gene transfer in the absence of retroviral producer cells and in presence of an effective immobilized amount of a recombinant polypeptide which increases the frequency of transduction of the hematopoietic cells, said recombinant polypeptide containing a first amino acid sequence represented by the formula: (SEQ ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu

Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind retroviruses;

and a second amino acid sequence represented by the formula: (SEQ. ID NO. 2)

Asp Glu Leu Pro Gln Leu Val Thr Leu Pro His Pro Asn Leu His Gly Pro Glu Ile Leu Asp Val Pro Ser Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind primitive hematopoietic cells.

63. The cellular grafting method of claim 62 wherein said viable hematopoietic cells are enriched in hematopoietic stem cells.

64. The cellular grafting method of claim 65 wherein said viable hematopoietic cells are human hematopoietic cells enriched in human hematopoietic stem cells.

65. The cellular grafting method of claim 64 wherein said hematopoietic cells are a substantially homogenous population of human hematopoietic cells characterized as adherent-negative, low density, mononuclear cells.

66. The cellular grafting method of claim 65 wherein said hematopoietic cells have been transduced by a recombinant retrovirus vector containing an exogenous gene to correct a protein deficiency or abnormality in the cells.

67. The cellular grafting method of claim 62, wherein said recombinant polypeptide is selected from the group consisting of CH-296 and H-296.

68. A method for localizing a retrovirus, comprising:

incubating a medium containing a retrovirus in contact with an effective, immobilized amount of a polypeptide containing an amino acid sequence which provides the retrovirus binding activity of the Heparin-II binding domain of fibronectin.

69. The method of claim 68 wherein said polypeptide contains an amino acid sequence represented by the formula: (SEQ. ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp

Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit the retrovirus-binding activity of the Heparin-II domain of fibronectin.

70. A method for making a construct useful for enhancing retroviral-mediated DNA transfer into a predetermined target cell, comprising:

selecting a ligand which binds with specificity to said target cell; and

covalently coupling said ligand to a polypeptide containing an amino acid sequence which exhibits the retrovirus-binding activity of the Heparin-II domain of fibronectin.

71. A method for increasing the frequency of transduction of a population of viable target cells by a retrovirus, comprising infecting the cells with a retrovirus in the presence of an effective immobilized amount of a construct having a ligand which specifically binds to the cells covalently coupled to a polypeptide which binds the retrovirus, said polypeptide containing an amino acid sequence which exhibits the retrovirus-binding activity of the Heparin-II domain of fibronectin.

72. The method of claim 71, wherein said amino acid sequence is represented by the formula: (SEQ. ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu

Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind retroviruses.

73. A kit for use in conducting retroviral-mediated DNA transfer into viable hematopoietic cells, comprising:

(a) substantially pure polypeptide containing (i) a first amino acid sequence of the Heparin-II domain of human fibronectin which exhibits retroviral-binding activity and (ii) a second amino acid sequence which provides the cell-binding activity of the CS-1 domain of human fibronectin;

(b) an artificial substrate upon which to incubate a retroviral vector in contact with human hematopoietic cells; and

(c) hematopoietic cell growth factors for prestimulating the hematopoietic cells.

74. The kit of claim 73 wherein said substantially pure polypeptide is immobilized on said artificial substrate.

75. The kit of claim 73 which also includes:

(d) a recombinant retroviral vector for transducing the human hematopoietic cells.

76. The kit of claim 73 wherein said substantially pure polypeptide (a) comprises a recombinant polypeptide having an amino acid sequence represented by the formula: (SEQ ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit retrovirus-binding activity.

77. The kit of claim 76 wherein said substantially pure recombinant polypeptide is immobilized on said artificial substrate.

78. The kit of claim 78 wherein said recombinant polypeptide is selected from the group consisting of CH-296 and H-296.

79. In a method of gene transfer into mammalian cells by a replication-defective recombinant retrovirus vector, the improvement comprising conducting the gene transfer without cocultivation and in the presence of substantially pure fibronectin, substantially pure fibronectin fragments, or a mixture thereof, so as to increase the frequency of the gene transfer.

80. A method for transduction of viable mammalian cells by a replication-defective recombinant retrovirus vector, comprising infecting the cells in culture with a replication-defective recombinant retrovirus in the presence of substantially pure fibronectin, substantially pure fibronectin fragments, or a mixture thereof, to produce transduced cells.

81. The method of claim 80, wherein the infecting is in the presence of a fibronectin fragments containing the Heparin-II binding domain of fibronectin.

82. The method of claim 81, wherein said domain has an amino acid sequence represented by the formula: (SEQ ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp

Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr;

or a sufficiently similar amino acid sequence thereto to exhibit the retrovirus-binding activity of the Heparin-II domain of fibronectin.

83. The method of claim 82, wherein said fibronectin fragments comprise recombinant fibronectin fragment selected from the group consisting of CH-296 and H-296.

84. An improved method for cellular grafting, comprising the steps of:

obtaining viable mammalian cells from an animal donor;

infecting the cells with a replication-defective recombinant retrovirus vector containing exogenous DNA to produce transduced cells, the infecting being in the presence of an immobilized amount of fibronectin and/or a fragment thereof effective to increase the efficiency of cellular transduction by the retrovirus vector; and

introducing the transduced cells into an animal recipient as a cellular graft.

85. The method of claim 84, wherein said infecting is conducted in the absence of retroviral producer cells and in presence of an effective immobilized amount of a recombinant polypeptide which increases the frequency of transduction of the hematopoietic cells, said recombinant polypeptide containing a Heparin-II binding sequence having an amino acid sequence represented by the formula:

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu

Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr

or a sufficiently similar amino acid sequence thereto to exhibit the ability to bind retroviruses.

86. The method of claim 85, wherein the recombinant polypeptide is recombinant fibronectin fragment selected from the group consisting of CH-296 and H-296.

87. A cellular population suitable for subjection to retroviral-mediated gene transfer, comprising:

viable mammalian cells in a culture medium containing immobilized fibronectin, immobilized fibronectin fragments, or an immobilized mixture thereof.

88. The cellular population of claim 87, wherein said culture medium contains immobilized fibronectin fragments containing the Heparin-II binding domain of fibronectin.

89. The cellular population of claim 88, wherein said domain has an amino acid sequence represented by the formula: (SEQ. ID NO. 1)

Ala Ile Pro Ala Pro Thr Asp Leu Lys Phe Thr Gln Val Thr Pro Thr Ser Leu Ser Ala Gln Trp Thr Pro Pro Asn Val Gln Leu Thr Gly Tyr Arg Val Arg Val Thr Pro Lys Glu Lys Thr Gly Pro Met Lys Glu Ile Asn Leu Ala Pro Asp Ser Ser Ser Val Val Val Ser Gly Leu Met Val Ala Thr Lys Tyr Glu Val Ser Val Tyr Ala Leu Lys Asp Thr Leu Thr Ser Arg Pro Ala Gln Gly Val Val Thr Thr Leu Glu Asn Val Ser Pro Pro Arg Arg Ala Arg Val Thr Asp Ala Thr Glu Thr Thr Ile Thr Ile Ser Trp Arg Thr Lys Thr Glu Thr Ile Thr Gly Phe Gln Val Asp Ala Val Pro Ala Asn Gly Gln Thr Pro Ile Gln Arg Thr Ile Lys Pro Asp Val Arg Ser Tyr Thr Ile Thr Gly Leu Gln Pro Gly Thr Asp Tyr Lys Ile Tyr Leu Tyr Thr Leu Asn Asp Asn Ala Arg Ser Ser Pro Val Val Ile Asp Ala Ser Thr Ala Ile Asp Ala Pro Ser Asn Leu Arg Phe Leu Ala Thr Thr Pro Asn Ser Leu Leu Val Ser Trp Gln Pro Pro Arg Ala Arg Ile Thr Gly Tyr Ile Ile Lys Tyr Glu Lys Pro Gly Ser Pro Pro Arg Glu Val Val Pro Arg Pro Arg Pro Gly Val Thr Glu Ala Thr Ile Thr Gly Leu Glu Pro Gly Thr Glu Tyr Thr Ile Tyr Val Ile Ala Leu Lys Asn Asn Gln Lys Ser Glu Pro Leu Ile Gly Arg Lys Lys Thr;

or a sufficiently similar amino acid sequence thereto to exhibit the retrovirus-binding activity of the Heparin-II domain of fibronectin.

90. The method of claim 89, wherein the fibronectin fragments comprise recombinant fibronectin fragment selected from the group consisting of CH-296 and H-296.

91. A cellular population comprising viable mammalian cells transduced by retroviral-mediated gene transfer in the absence of retroviral producer cells and in the presence of an effective immobilized amount of fibronectin, fibronectin fragments, or a mixture thereof, so as to increase the frequency of transduction of the cells.

92. The cellular population of claim 91, wherein said gene transfer is conducted in the presence of a recombinant polypeptide which increases the frequency of transduction of the cells, said recombinant polypeptide containing a